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# A
# TREATISE
# ON THE
# BATH WATERS.

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A

# TREATISE

ON THE

# BATH WATERS:

Wherein are DISCOVER'D,
THE SEVERAL
PRINCIPLES of which they are COMPOS'D;
THE
CAUSE of their HEAT;
AND THE
MANNER of their PRODUCTION.

BY

## *RICE CHARLETON,*

Of BATH, M.B. F.R.S.

> *—Inter ſe quia nexus principiorum*
> *Diſſimiles conſtant,*————
> *Incolumi remanent res corpore, dum ſatis acris*
> *Vis obeat pro textura cujuſque reperta.*—LUCRET.

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# A Chemical Analyſis, &c.

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## CHAPTER I.

### *Of the* MINERAL SUBSTANCES *which the* BATH WATERS *bring up with them out of the Earth.*

THE Origin and Courſe of the BATH WATERS being unknown, we are deprived of thoſe Helps in our Search after their conſtituent Principles, which an Examination of the Subſtances they run through would afford. For as all ſuch Waters derive their Virtues from the Bodies they diſſolve during their Continuance in the Bowels of the Earth, or from the Steams of fermenting Minerals with which they are there impregnated; an Inveſtigation of this Kind is too eſſential and too uſeful a Part of their *Analyſis* not to be regreted, when we are deprived of its Aſſiſtance. But this Defect in the preſent Enquiry is however, in ſome Meaſure, ſupplied by the following Subſtances, which the Current of theſe Springs forces up from beneath.

THE Firſt, is a very peculiar Sort of Sand, of a dark Grey Colour. It appears to the Eye to conſiſt chiefly of ſmall Chryſtals, like thoſe of common Sand, intermix'd with black ſhining Particles, and Pieces, of a white chalky Earth. But when ſubmitted to a Chemical Examination, we find in it an Alcaline Principle, Iron and Brimſtone.

The 1ſt is evident from the violent Fermentation which Acids produce with it.

The 2d from digeſting it for a few Days in pure diſtill'd Rain-Water, which will thence become poſſeſs'd of all the Properties of a Natural Chalybeat: Or, if a Loadſtone is moved about in this Sand, ſeveral ſmall Particles of Iron will be attracted from thence by it.

The 3d Ingredient which enters its Compoſition, *viz.* Brimſtone, is diſcoverable from ſtrewing a ſmall Quantity of this Sand on a red-hot Poker, where it yields a blue Flame, and a ſuffocating Vapour: Or, from confining ſome of it in a Retort, whence the true acid Spirit of that Mineral may be obtained by Diſtillation.

To this Sand ſucceeds a ſoft black Mud, of a ſtrong ſulphurous Smell;

which yields by the before-mention'd Proceſs, a conſiderable Quantity of a taſteleſs, limpid, fœtid Water, that fermented with neither Acids nor Alcalies. The Neck of the Retort was lined with a fine ſtraw-colour'd Powder, which glitter'd, was taſteleſs, and gave no blue Flame in Burning; but the Vapour which aroſe from it was ſomething acid and ſuffocating. This Mud being rubb'd on Silver changes it black.†

In ſome of the Spring and Summer Months, it is uſual to ſee large black Cakes floating on the Surface of theſe Waters. They have been ſuppoſed to be ſome bituminous Matter, but are, in Reality, a Moſs ‡, as is evident by keeping a Part of them for a few Hours in a

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† Both the Sand and Mud are found in the Ciſterns, which are placed over the Springs of the ſeveral Baths.

‡ Mr. Ray in his *Sinopſis Stirp. Britannic.* calls this Plant the *Jelly-Moſs.*—Conferva Gelatinoſa, omnium tenerrima & minima Aquarum limo innaſcens.

Glaſs of common Water, which by waſhing off the Mud in which it grows, and that clots its Fibres together, gives them Liberty to expand, and to demonſtrate their being a Vegetable from their *Figure.* By Diſtillation it produces the uſual component Principles of its Tribe; from whence, with its being commonly to be found in other Places †, it cannot be ſuppoſed to impart any peculiar Virtues to the BATH WATERS: But how far they are obliged to either of the two preceding Subſtances in this Reſpect, we ſhall have a more fit Opportunity hereafter of ſhewing, when it is diſcovered of what Ingredients they are compoſed.

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† Gaudat limo nigro tenero & pingui & in Foſſis purioribus paſſim circa Londinum obſervetur toto fere anno.

*Synop. Stirp. Britan.*

# CHAP. II.

## *Of the* CHALYBEAT PRINCIPLE *in the* BATH WATERS.

THE BATH WATERS have ever been deem'd Chalybeat; and it is evident they are ſo, as well from their Smell and Taſte, as from the Phænomena produced in them by their Mixture with the following Materials.

1ſt. THE Water of each Bath, *viz.* the King's, Hot, and Croſs, inſtantly changed with Powder of Galls to a rich Purple.

2d. WITH a few Grains of powder'd Logwood, they at firſt ſtruck a reddiſh Purple, and in leſs than a Quarter of an Hour turn'd of a deep Violet.

3d. With Green Tea they acquir'd the ſame Colour as with Galls, but much fainter.

4th. With Pomegranate Bark, they became of a blueiſh Caſt, when placed in ſome Lights; and of a greeniſh Yellow in others, like thoſe changeable Silks, whoſe Colours vary according to the different Points of View they are obſerved in.

5th. Balaustines† produced in theſe Waters a Colour, which at firſt reſembled that of Galls, but it afterwards alter'd to a greeniſh Hue.

These Changes which Galls and other ſimilar Subſtances excite in Mineral Waters, are held to be a ſure Criterion of their containing a Chalybeat Principle; and Experiments of this Sort are commonly confined to a bare Demonſtration of its Exiſtence. But as it has been found by frequent Trials, that ſuch Waters *vary* from the fainteſt Shade of Purple to the deepeſt Black, in Proportion to the Quantity of this Ingredient, which they are poſſeſs'd of; and as they require a larger or a ſmaller Quantity of Galls to bring them to their higheſt Tint, in the ſame Ratio; ſuch Experiments may be conducted to a more uſeful Purpoſe, than that to which they are commonly aſſigned: For it becomes a Matter of no great Difficulty by preparing an *Artificial Chalybeat* Water, in which a known Portion of this Metal is diſſolved, to determine how much of it exiſts in the *Natural One:* It being a neceſſary Conſequence of the above Obſervations, that where two Waters ſtrike the ſame Colour with equal Quantities of Galls, that each muſt contain the ſame Quantity of Iron.

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† Flowers of the Wild Pomegranate Tree.

Mr. *Monro*, of *Edinburgh*, to whom the phyſical World is much obliged for many uſeful and curious Diſcoveries, has in the third Volume of the *Medical Eſſay*, given us one on the preſent Subject; in which he ſays, that in the Salt of Steel the Proportion of Iron is little more than a third Part, and that by diſſolving one Ounce of it in twenty Ounces of Water, 142 Drops of which Solution weigh 2 Drams, every ſuch Drop will contain $\frac{1}{75}$ of a Grain of Iron.

I PREPARED ſuch a Solution of the Salt of Steel, by diſſolving 240 Grains of it in 10 Ounces *Averdupois*†, of Water, and found, by a very accurate Ballance, that 97 Drops of it, let fall from a ſmall Glaſs Tube, exactly weigh'd 2 Drams. Theſe Drops were therefore larger than thoſe in Mr. *Monro*'s Calculation, and each of them contains $\frac{1}{47}$ of a Grain of Iron.

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† This is mention'd, becauſe in Mr. *Monro*'s Solution, the Water was weigh'd by Troy Ounces.

At the ſame Time, a ſtrong Tincture of Galls was alſo made, by digeſting one Ounce of them in Powder, with a Pint of Rain Water, in a gentle Heat for ſome Days; and with theſe Helps I proceeded in the following Manner, to diſcover the Quantity of the Chalybeat Principle, with which the BATH WATERS are impregnated.

I DROP'D the Tincture of Galls from a ſmall Glaſs Tube, in different Quantities, into Pint Glaſſes, of the ſame Shape and Thickneſs; and then immediately fill'd them with the Water as it came hot from the Pump. It was found, by repeated Trials, that 10 Drops of this Tincture were the preciſe Number, which brought the Water of the King's Bath to its higheſt Tint; and that five Drops were ſufficient for this Purpoſe in thoſe of the Hot and Croſs Baths.

The Water of the King's Bath ſtruck a warm, rich, roſy Purple; the others only differed from it in their Shades being lighter.

To imitate the Colour of the King's Bath-Water, two Drops of the Solution of Iron above-mention'd, added to three Pints of pure Rain Water, were ſufficient. For thus an artificial Chalybeat was produced, one Pint of which ſtruck, with 10 Drops of the Tincture of Galls, a Purple, from which that of the Natural One was not to be diſtinguiſh'd, but by the Warmth and Richneſs of its Tint.

It appears therefore from the preceding Experiments, that the Chalybeat Principle in a Pint of the King's Bath Water, is equal to the Quantity of Iron contain'd in two Thirds of a Drop of the Solution; which, by Calculation, comes out to be $\frac{1}{70}$ of a Grain nearly;

and as the Waters of the Hot and Croſs Baths are but of Half its Strength, there is in a Pint of either of theſe only $\frac{1}{140}$ Part of a Grain.

This Diſcovery, at firſt Sight, may ſeem prejudicial to their Reputation; but it would be doing the higheſt Injuſtice to theſe Waters, ſhould we attempt to explain their Virtues from only a Part of their Compoſition; or attribute to one Ingredient, what reſults from the happy Combination of *Several.* Beſides, this ſeeming Prejudice will be entirely remov'd, if it be conſidered, that the ſame Method of Inveſtigation being applied to other Chalybeat Waters, ſhews they are all impregnated with this Principle, in a Degree infinitely inferior to what might be imagined.

Should we not alter our Opinion of the Powers of Steel Medicines from hence? And conclude, as Nature deals this Mineral out ſo ſparingly, in her moſt ſanative Compoſitions, that its Efficacy depends far leſs on Quantity than the common Uſage of preſcribing it ſuppoſes.

It has been ſaid, that the Chalybeat Principle of the Bath Waters is *volatile*; that they looſe it by keeping; and thro' its Eſcape, become vapid and effœte. The Falſity of which Poſition will be ſhewn by the following Experiments.

1. Having fill'd a large Bottle at the Pump of the King's Bath; a wet Bladder emptied of its Air and with its Surface well oil'd, was tied cloſely over its Mouth; after a Time, the Bladder became diſtended, and the Vapour which was thus collected, being gathered into a large Bubble, was ſunk to the Bottom of a Glaſs which contain'd a weak Tincture of Galls. Upon running a Pin into that Part of the Bladder, where this Vapour was,

it ruſh'd out with conſiderable Noiſe, produced great Agitation in the Liquor, and fill'd it with Blebs of Air, which burſt as they arriv'd at it Surface; but excited no Alteration in its Colour, or ſhew'd the leaſt Marks of a *volatile* Chalybeat.

2. A LARGE Quantity of the King's Bath Water was diſtill'd from a Retort, in whoſe Neck a Hole was made, thro' which its more volatile Parts might eſcape; over this Hole was placed a Piece of ſpungy Paper, that had been ſoak'd in a ſtrong Tincture of Galls. The Paper was roll'd up into a conical Shape, and cover'd with a Glaſs Bell, which condenſed thoſe Vapours which aroſe in the Diſtillation, and return'd them again upon it. The Conſequence of this Experiment was, that tho' the Paper became thoroughly wet with the Vapour, yet it was changed to neither a Purple or a black Colour.

3. I PUT into a Receiver a ſew Fragments of a Gall Nut, and diſtill'd the Water of the ſame Bath into it from a Glaſs Retort, having firſt of all well ſecured their Junction by Cement and wet Bladders. The Water which was thus diſtill'd, remain'd entirely free from any the leaſt Tint, which could raiſe a Suſpicion of its being impregnated with Iron.

THE receiv'd Notion therefore, that the Bath Waters contain a *Volatile* Chalybeat Principle, is without Foundation. Surely its Effects muſt have appear'd in one or other of theſe Trials, either of which was ſo ſuſceptible of demonſtrating its Exiſtence: For one Drop of a weak Solution of Iron tinctur'd the Fluids of the firſt and third Experiments with a very diſtinguiſhable Purple, and being poured on the Paper which was uſed in the Second, (after it was dry) gave it a Blackneſs equal to what it would have acquir'd, had it been dipped in Ink.

But it may be aſked, if the Chalybeat Principle of the Bath Waters is not *volatile*, and does not fly off from them; why do they looſe their Power of tinging with Galls by being kept? The following Experiments will tell us.

Two Florence Flaſks were filled with this Water, and their Noſes inverted into Decanters of the ſame. One of the Flaſks was quite full; the other had an Air Bubble left on its Surface of two and ½ Inches Diameter. After 24 Hours, each was examined with Galls. The Water in the Flaſk where the Air Bubble was left, ſhew'd ſcarcely any tinging Property; but that in the other, which was quite fill'd, ſtruck immediately a vivid Purple, nearly equal to what it gives when juſt taken from the Pump.

Hence we ſee the Water is depriv'd of this Power by a bare communication with the Air; and that, even when it is preſerved in ſuch a ſituation as renders the eſcape of its Chalybeat Principle impoſſible. It would be abſurd to ſuppoſe *this* could paſs thro' the Pores of the Glaſs; or granting *it* to be capable of obtaining ſuch a paſſage, 'twill be a matter of the utmoſt difficulty to explain, why *it* did not leave the Waters in each Flaſk alike?

It is to the Air therefore alone, that ſuch alterations are to be attributed, which, (to uſe the words of a very judicious Writer †) 'by its inceſſant 'elaſtic Action, promotes ſome degree

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† See Dr. *Hales* Experiments on Steel Waters, &c. Page 105.

‘ of Agitation or Ferment in the Wa-
‘ ter, cauſing the mineral Particles there-
‘ by to diſintangle themſelves from the
‘ Water, and to coaleſce into new Com-
‘ binations of ſo much larger Size as
‘ diſqualifies them to be any longer
‘ ſuſpended in the Water; they then
‘ precipitating to the bottom and ſides
‘ of the Bottles, partly in the form of
‘ a yellowiſh Ocre, and partly in cloudy
‘ Flocks or Thrumbs.

WHERE the Air is ſecluded, no change of this kind enſues; nor does it happen to a Water with which ſome acid Spirits have been mixed; theſe being repugnant to any putrid Agitation which that reſtleſs Element can excite ‡. Beſides it is a Fact, that when the Bath Waters have loſt their tinging Properties, they will acquire them again after they have undergone a thorough Fermentation; which it would be impoſſible they could do, was their Chalybeat Principle *volatile.*

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‡ Acid Spirits, beſides their Power of preventing any putrid Agitation in the Water, have ſtill a further one which greatly contributes to preſerve its tinging Properties, and that is their keeping the Chalybeat Principle ſufficiently diſſolved, attenuated, and mixed with the Water: And hence, by dropping Spirit of Sulphur, or Spirit of Vitriol, into the Bath Waters, I have preſerved their tinging Properties for a great length of Time, tho’ the Bottles in which they were kept have been corked only in a common manner. Without theſe acid Spirits, the Waters are intirely deprived of them in a few Days.

WHAT theſe Waters principally loſe when they are withdrawn from their Spring, is their Elementary Fire.

I HAD a Glaſs Veſſel made of a Globular ſhape, from whence aroſe two Tubes, the one Capillary, the other of $\frac{1}{4}$ of an Inch diameter, and both of three Inches in length. This Veſſel was fill'd with the Water of the King's-Bath, taken hot from the Pump, to the top of each Tube; the larger of which was then covered with a piece of Gold-Beater's Skin, and ſome Putty, which ſeparated its Contents from all contact with

the

the external Air. By the next Morning the Water in the Capillary Tube had ſunk 2 and $\frac{1}{2}$ Inches nearly, and required ſix Grains of the ſame Water (which was cold) to raiſe it to the Height it was firſt at.

HENCE we ſee the Bath Water increaſes in its ſpecific Gravity, as this Principle flies off from it ; and that its particles approach nearer to each other, and the whole volume of the Fluid is condens'd. Which alteration in the Arrangement and Mixture of its component parts, join'd to the loſs of this Ætherial Fire, is probably the reaſon why its Virtues can never be reſtored, when it is once grown cold.

THE Heat of the ſeveral Baths, as taken by *Farenheit*'s Mercurial Thermometer, is as follows :

THE Water of the King's-Bath,

where it is of the greateſt Warmth, raiſes the Mercury to 103 degrees; and ſinks it from thence, in its cooleſt Part, to 100.

The Thermometer ſtands in the Hot-Bath at 100, or 101.

The different degrees of Heat in the Croſs-Bath, are 93 and 94.

The Heat of the Queen's-Bath, is from 99 to 98.

The Waters which are pump'd up from the *Ciſterns* of the ſeveral Baths for *Drinking*, and which are convey'd thro' Pipes immediately from their Source, were found to be of various Degrees of Heat, at different times of Trial.

Thus the Water which flows from the Pump of the Croſs-Bath, has deſcended from 110 degrees, thro' all the intermediate ones, to 105.—That of the Hot-Bath, from 116 to 112.—And the Water of the King's-Bath Pump, from 116 to 114.

It is uſually thought, that the Bath Water retains its Heat longer than common Water heated to the ſame degree; but it did not appear to do ſo, by the moſt accurate Experiments that could be made.

It were to be wiſhed among the ſeveral conveniences of Bathing and Pumping which the different Heats of theſe Baths afford, that we had a *Vapour* Bath; or a contrivance to let out the Steam of the Water (to which an artificial Heat might be given where the natural one was inſufficient) on any part of the Body whence Obſtructions were to be removed. The Advantages of ſuch an Application are much ſuperior in many Caſes to the common methods of Pumping, and are attended with none of its Inconveniences.

The amazing Power of warm Vapour has been abundantly ſhewn by its effects in *Papin's Digeſter*, where the hardeſt Bones are in a few moments rendered ſoft and pappy ; but a ſimple Experiment is ſufficient for our purpoſe, to demonſtrate how much more penetrating and diſſolvent Water is when thus rarefied, than in a more condenſed ſtate, tho' poſſeſs'd of the greateſt Heat it is capable of attaining.

> Put a ſmall quantity of Salt of Tartar into a Glaſs Pan, and tye a piece of dry Bladder over its Mouth : Now boiling Water may be for a long time poured on this Bladder, without getting through its Pores ; whereas the Steams of ſuch Water gain an immediate admiſſion, which

they demonſtrate by diſſolving the Salt almoſt as ſoon as they are applied.

THE Inconveniences of *Pumping*, proceed from the Weight and Preſſure of the Water, which (together with its Heat) excite a vibratory and impulſive motion in the obſtructed Veſſels, that puſhes forward their ſtagnant Contents. If theſe are liquid enough to paſs the bounds of their confinement, Succeſs will attend the application. But where they are too viſcid; where they are endued with an acrimonious Diſpoſition; where the Conſtitution of the Patient is hot and feveriſh; or at leaſt in that ſtate at the time of uſing the *Pump*, an Inflammation of the Part muſt be the conſequence; which, if great care be not taken, is followed by a Generation of *Matter*, whoſe moſt favourable termination calls for the *Cauſtic* or *Inciſion-Knife*.

BUT none of theſe *Ills* can proceed from the *Vapour* Bath: It removes Obſtructions by diſſolving the hardened Juices which form them, and not by ſtimulating the Veſſels to puſh them forward thro' narrower *Paſſes* into the wider *Roads* of *Circulation*. The Particles of Water in this attenuated ſtate, find an entrance thro' the Pores which is denied them in any other; and by the relaxing Quality which theſe Vapours poſſeſs, they open an eaſy paſſage thro' the Skin for the obſtructed *Humours*, while they liquify them ſufficiently to make their eſcape.

# CHAP. III.

## *Of the* SULPHUREOUS PRINCIPLE *in the* BATH WATERS.

IT is a controverted Point, whether or no the Bath Waters are impregnated with Sulphur. Probably the indiſcriminate uſe of that *Term*, and of common *Brimſtone*, has been the occaſion of this diſpute. The latter is only applicable to a particular Mineral, whoſe Characteriſtics are its yellowiſh colour; its great Inflammability; its burning with a blue Flame, and an acid ſuffocating Vapour: Whereas the former ſhould be underſtood in a much more extenſive Senſe, ſo as to comprehend all *unctuous Bodies* in general. And hence, if any ſuch can be diſcovered in theſe Springs, it has all juſt right to be called their ſulphureous

Principle, how much ſoever it may differ from common Brimſtone.

It has already been ſhewn that this Mineral exiſts in the Bath Sand; but whether it actually enters the Compoſition of the Waters, is what I ſhall here endeavour to decide.

I judged that the moſt likely Means of Succeſs would be to make artificial Brimſtone Waters, and to add a diverſity of Mixtures to them, and to the Bath Water at the ſame Time: It would be thus eaſy to diſcover how far the Phænomena produced in each agreed; and conſequently whether the natural Water was impregnated with the ſame Ingredient as the artificial one, or not.

With this View, therefore, there was prepared two ſorts of Brimſtone Waters. The *firſt*, by melting the Flowers of Brimſtone with Salt of Tartar, which together conſtitute a mixed Body that readily diſſolves in Water. The *ſecond*, by pouring common Spring Water on pounded Stone Brimſtone, and returning it on again after it had ſoak'd through, 'till it became ſufficiently ſaturated with that Mineral.

To equal quantities of theſe Fluids, there were added 30 Drops of a Solution of *Sublimate* in diſtill'd Rain Water; and at the ſame Time a like Number were dropp'd into that of the Bath.

NUMBER I. Or the Water prepared with Brimſtone and Salt of Tartar, changed inſtantly to a fine Orange Colour: Afterwards it grew thick, and let fall a yellowiſh Sediment; which being dried, was flung on a red-hot Iron, where it burnt with a blue Flame.

NUMBER 2. Or the artificial Water

ter made from Brimſtone alone, appeared of a beautiful Pearl when held from the Light; but oppoſite to it of a Straw Colour. On ſtanding it became opake and milky, and a fine white Powder precipitated which burnt blue on a hot Iron.

The Bath Water ſhewed no alteration at firſt from this Mixture: But at length a Scum aroſe, and cover'd its Surface, which reflected an infinite Variety of the moſt beautiful Colours.

From this Claſs of Experiments, we find that the Bath Water bears no kind of Similitude to the artificial ones: We ſhall therefore examine them with a Solution of *Quickſilver* in *Aqua Fortis*, added to each in the ſame Quantity as before. With this:

Number 1, became firſt of an

Orange, and afterwards turn'd to a Pearl Colour. Its Precipitation, which was of a Cream, yielded a weak blue Flame in burning.

NUMBER 2. became milky. In a ſide Light the Mixture had a blueiſh Tint; in an oppoſite one, a faint Yellow. The Powder which was depoſited at the bottom of the Glaſs, was white, and burnt blue.

THE Bath Waters reflected a fine bright Orange. Its Sediment was of the ſame Caſt, and ſhewed no Signs of Inflamability.

WE here find ſome Reſemblance between the Bath Water and Number 1, which conſiſts in their both ſtriking pretty nearly the ſame Colour: But as this is owing to the *alcaline* Principle that each contains, as will be ſhewn when we come to treat of the Salts and

Earths which are in the Bath Waters; it muſt not from this Similarity alone be concluded that they are both impregnated with the ſame ſulphureous Ingredient.

A THIRD Trial was made on each of theſe Waters with a Solution of *Silver* in *Aqua Fortis.*

In Number 1, the Liquor at top was of a dirty White, at bottom of a dark Brown. The Precipitation was of a greyiſh Colour, and burnt with a pale Blue.

In Number 2, the Fluid was dark and muddy. A black ſhining Powder ſubſided, which flamed with a vivid Blue.

In the Bath Water, dark Clouds were inſtantly form'd, which gradually becoming black, at length deſcended and formed a Sediment of the ſame Colour. This black Matter gave no Flame on a red-hot Iron, but ſmoak'd much, and turn'd to a Calx.

All theſe Waters agree here in one particular, which is the Blackneſs they give to the Silver that's precipitated. This we know is one of the properties of common Brimſtone; it is owing to the acid part of that Subſtance; and other Mineral Acids are capable of producing the ſame. Thus if pure diſtill'd Rain Water is well ſaturated with common Salt that has been purified for Uſe, it changes the Silver which it precipitates equally black with the above-mention'd Waters. It does not therefore follow from this Experiment alone, without the aſſiſtance of other concurrent Proofs, that the Bath Water is impregnated with *common Brimſtone*. But upon the whole the contrary is to be concluded, ſeeing its Precipitations have no where in theſe trials produced the genuine and diſtinguiſhing Characteriſtics of that Mineral, *viz.* a *blue Flame* and a *ſuffocating acid Vapour.* To which we may add, that no alterations are produced in the Bath Waters with *Foſſil* Acids; whoſe well known property it is to precipitate this *Body* from the Menſtruum in which it is diſſolv'd, and at the ſame time to occaſion a moſt fœtid diſagreeable ſmell. Neither does their Reſiduum (the ſolid contents of the Water obtained by evaporation) when flung on a red-hot Iron, or on live Coals, give any cauſe to ſuſpect the contrary; which it moſt certainly would do, was ever ſo ſmall a portion of real Brimſtone mixed with it.

As this Mineral therefore does not enter into the compoſition of the Bath Waters, I ſhall proceed to another ſpecies of Enquiry by which the Nature and

Exiſtence of their *true* ſulphureous Principle will be diſcover'd and aſcertained.

One dram of Salt of Tartar, and four drams of the Reſiduum of theſe Waters, were ground together into a powder, and kept in a Crucible over a ſtrong Fire 'till they grew quite hot. This powder was immediately flung into a Florence Flaſk, which contained about half a pint of pure rectified Spirit of Wine. The Spirit quickly became tinged, of a rich golden Colour, and acquired, by digeſtion in a Sand heat, a grateful fragrancy of Smell, with a hot, pungent, Spicy Taſte.

This Experiment was made in imitation of the 154th Proceſs in *Boerhaave*'s Chemiſtry ; where he ſhews the method of diſſolving common Brimſtone in Alcohòl or highly rectified ſpirit of Wine :

Wine: To which *Solution*, the Tincture here obtained bore a perfect reſemblance.

In thoſe Deductions which that great Chemiſt has drawn from this Proceſs, he obſerves, that Sulphur (by which he means common Brimſtone) muſt firſt be opened by an Alcaly before it will diſſolve in the Spirit.—That this Subſtance frequently lies concealed in many Foſſil Bodies, from whence Tinctures have been extracted, and impoſed on the World for the moſt valuable Metallic ones. An Inſtance of which he gives in one which was boaſted to have been made from Gold, and concludes with an Obſervation preventive of ſuch impoſitions. *As ſoon* (ſays he) *as a ſkilful Artiſt diſcovers that a fixed Alcaly is employ'd in making them, he knows they muſt proceed from Sulphur.* † Conſequently, the Tincture here obtained from the Reſiduum of the Bath Waters, muſt proceed from a ſulphureous Principle of one kind or other which it contains. But that this is not *common Brimſtone* is evident from hence, that when diſtill'd Vinegar was added to this Tincture, no offenſive ſmell was produced ; nor did any thing precipitate which was poſſeſs'd of its properties. Whereas, if the ſame Acid be mix'd with the golden Tincture of the before-mention'd Proceſs in *Boerhaave*'s Chemiſtry, there ſoon ariſes a *ſtercoraceous Odour*, and *that Mineral* ſubſides.

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† Simul ac enim cognoſcitur Alcali requiri ad eaſdem conficiendas, peritus Artifex ocyus cognoſcit de Sulphure naſci.

The ſulphureous Principle therefore which is contained in the Reſiduum of theſe Waters bears only this reſemblance to common Brimſtone, that they both give a like Colour to ſpirit of Wine.

Now if we conſider the Compoſition

of that *Foſſil*, we ſhall find it is only one of its conſtituent Ingredients † which is capable of producing this effect. Neither its Alcaly, nor its Acid Spirit are in any degree equal to it, and therefore it muſt be its Bituminous Part, or as M. *Homberg* expreſſes it, *le vrai ſouffre du ſouffre commun*, to which this alteration of Colour is to be attributed.

PROBABLY the ſulphureous Principle of theſe Waters may conſiſt of ſuch a Bituminous Matter. The preceding experiment favours ſuch a ſuppoſition; and the ſubſequent ones will, I preſume, confirm it.

1. If a large quantity of the Bath Water, as 50 or 60 Gallons, be eva-

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† Brimſtone conſiſts of an Alcaline Part, an Acid Spirit, and a Bituminous Matter. *Vide*, Eſſai de L'Analyſe de Souffre Com. *Memoirs de L'Acad. Royal*, *An.* 1703.

porated with a very ſlow fire nearly to a dryneſs, or 'till only a Quart or three Pints of it be left; this remainder being poured off from the earthy parts, which the operation has collected, and paſſed thro' filtrating paper, appears in reſpect of its Colour like Mountain Wine, and, in its Smell, reſembles the Balſam Tolu.

2. If an equal quantity of pure ſpirit of Wine be poured to this *Amber-colour'd* Water, the mixture immediately becomes turbid and milky, and continues ſo 'till the precipitation of a ſaline uncryſtaliz'd Maſs reſtores it to its original tranſparency and colour: The latter being now render'd fainter by the diviſion of the *Sulphureous Matter*, which produced it, through the additional quantity of the Spirit of Wine.

3. When this ſaline Maſs has entirely ſubſided, decant the clear Liquor and gently evaporate it. The Vapour which at firſt ariſes is highly perfum'd, but grows leſs ſo in proportion as the Spirit of Wine diminiſhes. When this is entirely exhaled the Watry part of the Mixture recovers its former *Balſamic* ſmell, and being at length, totally driven away in Steam, there remains a thick ſoapy Liquor, like common Oil, of a hot, aromatic, pungent Taſte, of a grateful fragrancy, and of a dark-brown Colour.

This is the ſulphureous Principle of the Bath Waters. It's an exceeding fine aromatic Balſam, entirely diſſimilar from common Brimſtone, which has hitherto been ſaid to conſtitute this part of their compoſition.

It is impoſſible to determine the

preciſe quantity of this Principle in any aſſign'd Portion of the Water, becauſe much of it flies off during the ſeveral Evaporations which are neceſſary to collect it.

# C H A P. IV.

## *Of the* SALINE *and* EARTHY PRINCIPLES *of the* BATH WATERS.

WATER is ſo ready and ſo univerſal a Solvent for all the various ſpecies of Salts, that there is hardly ever found a Spring ſo pure, but ſome one or other of this Claſs of Bodies make a part of its contents. Mineral Waters eſpecially are never free from ſuch Ingredients. Among them there are ſome which derive their whole Virtue from hence; and indeed it would be hard to conceive how without ſuch aſſiſtance they could lay claim to that Appellation, or be productive of any Medicinal effects.

The kinds of Salt which ſuch Waters contain are diſcoverable by two methods of examination. The firſt conſiſts in the addition of peculiar Subſtances to the Water, from whence certain effects enſue that characterize the Salts which produce them: And the ſecond, in evaporating *it* to a dryneſs, or 'till only an Earthy matter remains, from whence the Salts are afterwards to be ſeparated.

But introductory to theſe Inveſtigations, it may not be improper in this place to premiſe a ſhort and general Hiſtory of the different Species and Properties of Salts; which, tho' unneceſſary to many Readers, may yet be of ſuch uſe to others, whoſe knowledge in Chemiſtry is of ſmall extent, that without it, the following account of the Salts which are diſcovered in the Bath Waters would be perfectly unintelligible.

‘ Salts, then, are defin’d to be Foſ-
‘ ſil Bodies, fuſible by Fire, and con-
‘ gealable again by Cold into little
‘ Glebes or Cryſtals; ſoluble in Wa-
‘ ter ſo as to diſappear therein, and
‘ impreſſing a ſenſation of Acrimony
‘ on the Tongue.’ †

This definition is general, and takes in the chief properties of all Salts whatever; but as there ſubſiſt very eſſential and peculiar differences among them, they have been aptly divided into three diſtinct Claſſes, which are diſtinguiſhed by the terms, Acid, Alcaline, and Neutral.

The properties of Acid Salts are their particular Taſte and Smell; the fermentation they produce with alcaline and earthy ſubſtances; their diſſolving

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† Note on *Boerhaave*'s Chemiſtry, by *Shaw*, Vol. 1. Page 104.

Metals; and their ſtriking a red colour with the Juices of the Sun-Flower, Roſes, and Violets.

Alcalies are characterized by their maukiſh urinous Taſte; by their effervеſcing with Acids; by their precipitating Metals and other Subſtances diſſolv'd in them; by their readily uniting with Oils and Sulphureous Bodies; by their changing the Juices of the Sun-Flower, Roſes, and Violets green; and laſtly by their diſſolving and running into a fluid ſtate when expoſed to the Air.

The third Claſs of Salts which are term'd Neutral, are conſtituted by the union of the preceding ones, and when perfect, neither ferment with Acids nor Alcalies, or indeed poſſeſs any of their properties. They are alſo ſufficiently diſtinguiſhed by their power of cryſtalizing, or ſhooting into regular diſtinct forms, which belongs not to either of the others.

As all Salts whatever are comprehended under one or other of the preceding Claſſes, and poſſeſs the peculiar Marks of their Tribe; they are in a great meaſure to be diſcover'd by the following Experiments, as appears from their application in the preſent Enquiry.

1. HAVING mix'd ſome Syrup of Violets with the Bath Water, it ſoon changed to a deep vivid green.

2. WITH a ſolution of Quickſilver in Aqua Fortis it immediately became opake and yellow, and an Orange colour'd Powder precipitated.

3. ACIDS cauſe no effervеſcence with the Water, but their acrimony

is greatly ſheath'd and deſtroy'd by it.

4. NEITHER with Alcalies is any fermentation excited.

5. A SOLUTION of Silver in Aqua Fortis turns the Water Milky, and the Metal ſubſides. †

FROM the two firſt of theſe Experiments we learn that the Water contains an Alcaly.—From the third, that this Alcaly is either but in a ſmall quantity, or that it is not of a very active nature.—From the fourth, that no Acid in a ſeparate unmix'd ſtate has any ſhare in its compoſition.—And from the laſt, that Common Marine Salt makes a part of its contents.

As the phænomenon produced in the

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† The Waters of each Bath ſhew the ſame appearances.

ſecond Experiment admits only of the following ſolution, its explication therefore becomes an evidence for the veracity of that deduction which was drawn from it. For the Menſtruum in which the Quickſilver is diſſolved being a ſtrong Acid, is on its mixture with the Water changed to a Neutral State by the Alcaline Principle which exiſts there; and being thus ſo much alter'd from its original nature, it conſequently is now no longer capable of ſuſtaining that Mineral.

To explain why Milky Clouds are generated in the Water by dropping into it a Solution of Silver in Aqua Fortis, and why from thence, together with the precipitation of that Metal, we conclude it contains common Marine ſalt: It muſt be obſerved, that the two moſt perfect Metals, Silver and Gold, diſſolve each in its own peculiar Menſtruum, ſo as that the one is not in the leaſt affected by what proves a ſolvent for the other.—Thus Silver diſſolves in Aqua Fortis, but Gold does not.—Again, Gold diſſolves in Aqua Regia (a liquor made by the combination of Aqua Fortis with Marine Salt) but Silver is not in the leaſt acted upon by it. When therefore the ſolution of Silver is mixed with the Bath Water, the common Marine ſalt which is contained in it uniting itſelf with the Aqua Fortis, produces that peculiar Menſtruum (the Aqua Regia) which acts only upon Gold: In which caſe, the Silver muſt neceſſarily be diſcharged from a Fluid now render'd incapable of diſſolving it; and thus for a time it ſwims about in the Water, obſcures its tranſparency with Milky Clouds, and at length precipitates to the bottom of the Glaſs in which the mixture was made.

It has been obſerved of Neutral Salts, that they alone have the power of congealing

gealing into Glebes or Cryſtals; the figures of which being extremely different, and each Salt always retaining its own peculiar Shape, this property becomes one of the moſt diſtinguiſhing ſigns of their ſeveral Species.—Thus common Marine ſalt produces Cryſtals which are Cubes: Thoſe of Nitre are Pryſmatic: Thoſe of Alum Octogons; and ſo on of the reſt.

Now to obtain the ſalts of a Mineral Water in this perfection, that from their proper ſhape it may be determined to what Claſs they belong, it is neceſſary to evaporate large quantities of it, that all the fluid part being diſperſed in Vapours, the Earthy and Saline ones may alone be left; from whence the latter are to be ſeparated by digeſtion in warm diſtill'd Rain Water, which being filtred and gently evaporated 'till a fine ſkin covers its ſurface, muſt then be kept in a cool place, and thus the

Salts will in time be found cryſtaliz'd in their diſtinct figures.

If the Bath Water is treated according to theſe directions, it exhibits two ſpecies of Salts, whoſe forms are elegantly expreſs'd in the following Plate, Fig. 1.

But I ſhall defer the particular deſcription of theſe for the preſent, to take notice of ſome phænomena which ariſe during the methods made uſe of to obtain them.

Whilst the Water evaporates, its ſurface is continually covered by broad thin Flakes, which as they gradually increaſe in their weight by the addition of ſimilar particles, at length become too heavy to be ſupported; and by ſubſiding, give room for others of the like nature to ſucceed. The ſides alſo of the Veſſel in which the evaporation is performed, are incruſted with a hard, ſaline, white Matter, extremely pungent, and biting on the Tongue.

WHEN the Water is entirely exhaled, the Reſiduum conſiſts of the before-deſcribed Flaky ſubſtances, and (if the heat uſed during the Proceſs has been moderate) is of a *brown* Colour, has a ſoft ſoapy feel, and a *Balſamic* ſmell. On the contrary, if the heat has been violent, it is depriv'd of all theſe properties. The *Balſamic* ſmell is not to be perceiv'd; its Floculi become brittle, and harſh to the touch; and change their natural brown for a ſnowy whiteneſs. Which alterations, are other inconteſtable Proofs of a Bituminous Principle that originally exiſted in this Reſiduum; by whoſe eſcape the above changes neceſſarily enſue.

THIS Reſiduum has no diſtinguiſhable Saline taſte, but is rough and gritty in the Mouth.—It ferments violently with Spirit of Vitriol, and other Acids; as do alſo thoſe Saline Concretions which adhere to the ſides of the evaporating Glaſſes. — They raiſe no diſturbance whatever with Alcalies; and being digeſted in pure, diſtill'd, Rain Water, they communicate to it the property of turning *Green* with Syrup of Violets.

Such Appearances confirm thoſe concluſions, which were drawn from the changes the Bath Water underwent by the mixture of particular ſubſtances with it; and are further demonſtrations of its containing an Alcaline Principle. But whether this is a ſalt, or only an Earthy Matter inclining to that nature, we muſt be determined by the following Experiment.

Let a large quantity of the Water be evaporated 'till only a ſmall portion of it remains; this will be ex-

extremely ſalt, and if poured off from the Earthy parts, and exhaled to a dryneſs, we ſhall thus collect this principle by itſelf, and pretty free from every other addition.

THE Saline Maſs here obtained, neither ferments with Acids, nor produces any change of Colour with Syrup of Violets: Nor does the white concretion which ſticks to the ſides of the evaporating Glaſſes, yield any other than a perfect Neutral Salt, when diſſolv'd and cryſtaliz'd; and its filter'd Solution ſhews no ſigns of Alcaleſcency.—Hence this Alcaline Principle does not conſiſt in a *Salt*, but in an *Earthy Matter*; of which we ſhall hereafter ſpeak more particularly.

IT has been obſerved, that there are Two Species of Salts in the Bath Waters: The firſt of which reſembles in its figure Dr. *Liſter*'s Calcarious Nitre, and is undoubtedly the ſame Salt.—† Its Cryſtals are long and ſlender; they conſiſt of four unequal ſides, the upper and inferior being broader than the lateral ones. At one end, the Cryſtal terminates in Two Triangular ſurfaces, at the other, in Two inclined Planes. Fig. 2.

THIS Salt is at firſt remarkably cool in the mouth, but impreſſes a ſtrong bitter taſte as it diſſolves. It's free from any acrimonious biting ſenſation; nor has it that nauſeous ſavour which the common purging Salts leave behind them. Being flung into Milk which is near boiling, it curdles it, and produces a *Whey*. It ferments gently with Spirit of Vitriol, and yields a Gaſs, which ſmells like Aqua Fortis. It does not ferment with Alcalies, but turns Syrup of Violets of a faint green. Being flung on a red-hot Iron, it immediately melts, and runs into a fluid ſtate like Water, hiſſes, forms bubbles, and at length changes into a white Calx. On live Coals it produces the ſame appearances. If it's put before a Fire, or kept in a hot place, it loſes both its tranſparency and hardneſs; becomes white, and falls into a powder on the ſlighteſt touch.—We confin'd a few Ounces of this Salt in a Glaſs Retort, and gave it a ſtrong Fire for ſeveral Hours. There at firſt came over into the Receiver a conſiderable quantity of a taſteleſs, inſipid Water, which gave no Signs either with Acids, or Alcalies, or Syrup of Violets, of its being any other than a pure elementary Fluid. This was followed by a ſmall portion of an Acid Spirit. The Maſs which remained in the Retort was an Alcaline Earth.

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† Salis Calcarii Cryſtalli tenues, longæquê ſunt: iiſque mediis quatuor latera parallelogramma ſunt at feré inæqualia; ex alterâ vero parte, ipſe mucro ex binis planis lateribus triangularibus formatur, ex altera & adverſa parte duo plana quadrata habet, perpetuò ad contrarium cum priore illa parte poſitum.—*Tractatus de Fontibus Medicatis Angliæ.*

A SOLUTION of this Salt, precipitates Silver diſſolved in Aqua Fortis; which Property is, I believe, not eſſential to it, but is owing to ſmall portions of Marine Salt, which in the Microſcope are ſeen adhering to its Cryſtals.

'TIS this Marine Salt which makes the ſecond Species in the compoſition of theſe Waters, as is evident from its poſſeſſing the following ſigns.—1ſt, The Cubical Figure of its Cryſtals.—2d, Its peculiar Salt Taſte.—3d, If the Oil of Vitriol is dropt on it, there ariſes an acid ſuffocating Gaſs, or the true ſpirit of Sea Salt.

IN 56 cubic Inches, † or one Quart

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† The Wine Gallon is ſuppoſed to contain 231 Cubic Inches, but from an Experiment made in 1688 before the Commiſſioners of the Exciſe, &c. it was found that the preciſe content of the Standard Wine Gallon kept in *Guildhall* was but 224 Cubic Inches.

Wine meaſure of the King's-Bath Water, there is found both by its evaporation and diſtillation, 34 Grains of Reſiduum. The proportion of the Water therefore to its fixt Contents, is as 417 to 1.

TWENTY Grains of this Reſiduum diſſolve in Rain Water, the other 14 ſubſide. Hence the former are Salt, the latter Earth.

THESE two ſpecies of Salt exiſt in the King's-Bath Water, under different proportions. The Neutral, being to the Marine Salt, as 2 to 5; conſequently in a Wine Quart we have 5,714 Grains of the Neutral Salt, and 14,285 Grains of the Marine Salt.

ONE Quart of the Hot-Bath Water gave 30 Grains of Reſiduum; 17 of which were Earth, and 13 Salt.

The ſame quantity of the Croſs-Bath alſo left 30 Grains of Reſiduum; 10 of which were Salt, and the remainder Earth.

The proportion therefore of the Fluid parts to the Solid, in both theſe Waters, is as 472, 6 to 1.

The Water of the Hot-Bath contains a larger ſhare of the Neutral Salt, than the Croſs-Bath.

After theſe Salts are entirely ſeparated from the Reſiduum, there remains an Earthy Powder of a white Colour, and a perfectly inſipid Taſte.

Its peculiar Nature will be diſcovered by the following Experiments.

1ſt. It does not ferment with Oil of Tartar, or with any of the Alcaline Claſs.

2d. It gives a ſaint green to Syrup of Violets.

3d. It ferments violently with Spirit of Vitriol, and all other Foſſil Acids.

4th. After being calcin'd, it fermented more ſtrongly with Acids than before, but did not increaſe the Heat of common Spring Water, nor did any hiſſing or ebullition ſucceed on their Mixture.

5th. I added to this Earthy Matter a little Borax and Tallow, and then placed it in the Heat of a Wind Furnace for ſome Hours. When the Maſs had grown cold, and was pounded, the Loadſtone drew ſeveral ſmall particles of Iron from it.

From theſe Experiments we may with certainty conclude, that the Earthy part of the Bath Water is of an alcaline Nature; but it does not ſeem to be derived from Lime Stone, as in that caſe it would have ſhewn its peculiar properties after *calcination*, and conſequently have produced an ebullition with Spring Water, and increaſed its Heat.

It alſo appears that the Calx of the *Chalybeat* Principle of theſe Waters remains in their Reſiduum, and may be reſtored by proper methods to its genuine Metalleity; which is ſurely a convincing Proof that the general opinion of its being *Volatile*, is erroneous.

The Earthy Ingredient of theſe Waters is alſo to be obtained, by only mixing the Salt of Tartar or its Lixivium with them; for immediately on this addition, large white Clouds appear, and at length precipitate in a fine Powder; which (after being well waſh'd in ſeveral Waters, to ſeparate any part of the Alcaly which might have adhered to it) fermented violently with all the Mineral Acids in general.

THIS Powder ſhews no Signs of Inflammability whatever; it's merely an inſipid, abſorbent, alcaline, chalky Earth.

THE laſt Principle which we find in the Bath Waters, is Elaſtic Air. It has been obſerv'd by Dr. *Hales* that they contain leſs of this Element than other Mineral or even Common Waters do; and by following his method of ſeparating the Air from Fluids †, I obtained from a Florence Flaſk of the King's-Bath Water by 160 Degrees of Heat, a Bubble, whoſe diameter was only $\frac{5}{8}$ of an Inch; from the Hot-Bath Water one of $\frac{3}{8}$; and from the Croſs-

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† See *Veg. Statics*, Vol. 2, Page 270.

Bath about the ſame quantity: Whereas a Florence Flaſk of common Pump Water yields a Cubic Inch of Elaſtic Air.—Thoſe of *Briſtol* and *Holt*, a like portion; and *Piermont* Water, near twice as much. †

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† See *Veg. Statics*, Vol. 1, Page 181.

CHAP.

# C H A P. V.

## *How the* BATH WATERS *are generated.*

WE learn from the preceding Analyſis, that Elementary Fire, Elaſtic Air, an Alcaline Earth, a Neutral Salt, Common Marine Salt, Iron, and a fine Aromatic Balſam, mixed together and diſſolved in pure Water, conſtitute theſe Fountains of Health.

How Spring Water becomes poſſeſs'd of thoſe rich Ingredients, or in other Words, how the Bath Waters are generated, I ſhall now attempt to explain; and if I am able to make an Artificial Water, which ſhall reſemble the Natural one in its moſt eſſential Characteriſtics, it is all that can be expected in ſo difficult an Undertaking.

It has already been obſerv'd that theſe Waters bring up with them a very peculiar ſort of ſand, which is compoſed of an Alcaline Earth, Iron, and Brimſtone.—Upon the ſuppoſition then that common Spring Water, by running through large Beds of this Sand, becomes impregnated with the ſame Principles which we find in the Bath Waters; let us try how far the imitation of them will ſucceed, by making this the foundation of our enquiry.

I mixed with equal quantities of filings of Iron and of Stone Brimſtone, both reduced to a powder, about four Times their weight of Free-ſtone Sand. This Compoſition was moiſten'd into a paſte with common Water. In about 16 hours it became ſo violently hot as to break in pieces a ſtrong Earthen Pan in which it was kept; and it had lain ſcatter'd, and ſmoaking on the Ground, for ſome time before it was diſcover'd.

THIS accident render'd a repetition of the Experiment neceſſary: Which being made in a metalline Veſſel, the Succeſs was equal to expectation; for the Water poured on this Mixture grew hotter than that of the Bath, and having inadvertently ſuffered a Farenheit's Thermometer to ſink too deep among the Ingredients, the Mercury was flung up to the utmoſt extent of the Tube, whoſe Scale meaſured 393 degrees, and the Bulb of it burſt.

THIS Water in which the above Compoſition was digeſted, threw up a little Scum on its ſurface, and depoſited an Ocre on the ſides of the

Veſſel which contained it. † It was tranſparent and vivid — It had an agreeable chalybeat taſte — It inſtantly turn'd purple with Tincture of Galls—Green with Syrup of Violets—Of an Orange colour with a ſolution of Quickſilver in Aqua Fortis —Milky with Oil of Tartar per Deliquium—It precipitated a ſolution of Silver, and ſhew'd no change or alteration whatever with Acids.— In all which particulars it perfectly agrees with the Bath Water. Some difference was however obſerv'd between them, which aroſe from the different proportions of their ſeveral Ingredients; and not from the defect of any particular one, in the compoſition of the Artificial Water, which contained more of the Chalybeat, and leſs of the Alcaline Principle, than exiſts in the other.

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† The Guides clear the Surface of the Baths of this kind of Scum every Morning before the Bathers come in.—An Ocre may be ſcraped off the Sides and Stone-Seats of the Baths, which are in moſt places tinged by it of a yellowiſh colour.

The Artificial Bath Water left by evaporation a Reſiduum of a browniſh colour, which gave no flame on a red-hot Iron, but communicated a fine amber Tincture to ſpirit of Wine: And part of it being digeſted with diſtill'd Rain Water, and the ſolution cryſtaliz'd, the ſame ſpecies of Salts were obtained, as thoſe which the Natural Water yields by the like treatment.

From this Analogy between the Artificial and the Natural Waters, it is evident the latter are generated in the manner I have ſuppoſed. Thoſe ſmall differences which have been notic'd between them will ſcarcely be call'd objections to this Theory: For it would be abſurd to imagine that Chemiſtry can afford us the power of making ſo perfect a Compoſition, as that which Nature produces. It is the province of this Art to imitate her operations, and from that imitation to explain them. For, as Mr. *Lemery* obſerves, † 'Le 'meilleur moyen d'expliquer la Nature, '(s'il pouvoit être employé ſouvent) ce 'ſeroit de la contrefaire, & d'en donner pour ainſi dire, des repréſentations 'en faiſant produire les mêmes effects 'a des cauſes que l'on connoîtroit, & 'que l'on auroit miſes en action. 'Alors on ne devineroit plus, on verroit de ſes yeux, & l'on ſeroit ſûr que 'les Phenomenes naturels auroient les 'memes cauſes que les artificiels, ou du 'moins, des cauſes bien approchantes.'

It now only remains, that we ſhew, how from the action of theſe Bodies on each other, the ſeveral Principles of the Bath Waters are produced. To this end, it muſt be premiſed that Iron powerfully attracts Acids; and that Brimſtone is compoſed of an Acid Spirit, a Bitumen and an Alcaline Part.—When theſe two Bodies then come into cloſe contact, a ſolution of the Iron, by the Acid Spirit of the Brimſtone, immediately commences. By this means, that Metal is converted into a Salt or Vitriol; which Salt or Vitriol makes the *Chalybeat* Principle of the Bath Waters.

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† Hiſt. de l'Acad. Roy. An. 1700.

WHEN the Acid Spirit is thus ſeparated from the Brimſtone, its Bituminous and Alcaline Parts only remain: The former of which being rendered ſoluble in Water by the Aſſiſtance of the latter, conſtitutes the *Sulphureous* Principle of the Bath Waters.†—Hence we ſee it is impoſſible that theſe Springs ſhould contain common *Brimſtone*, as in their production the texture of that Mineral is entirely deſtroy'd, and it is robb'd of *one* of its *Conſtituents*.

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† Cette Balſam tire du ſouffre commun a une odeur grate & balſameque.—Analyſe du Souffre par M. *Homberg*.—*Memoirs de l'Acad. Royal, An.* 1703.

THE *Alcaline* Principle of the Bath Waters is ſupplied either from Freeſtone Sand, or ſome Chalky Earth: Probably from the latter, as the Artificial Water was found to contain leſs of this Ingredient than the Natural one.

MARINE Salt, or Sal Gemmæ (for they are both the ſame) is ſo univerſally diſtributed through the Bowels of the Earth, that there are no Spring Waters but what are impregnated with ſome portion of it.

THE Calcarious Nitre, or Neutral Salt of theſe Springs, is compoſed of a Vitriolic Acid, and an Alcaline Earth; and does not, I believe, primarily exiſt in them, any more than it does in the Artificial Water, which has been made in their imitation; but is generated while the Waters evaporate. For Heat applied to the Bath Waters, as well as to all other Chalybeats, deprives them of their properties of tinging with Galls; that is, it ſeparates the Acid from the Iron by which it was render'd miſcible with the Water, and the Metal ſubſides: While the Acid Spirit, in which it was before diſſolv'd, is abſorb'd by the Alcaline Earth, and this Neutral Salt is form'd.—Hence we ſee the Reaſon why no *Vitriol* or *Salt* of *Iron* is ever to be found in the *Reſiduum* of Chalybeat Waters; why this Principle exiſts there in the ſtate of a *Calx*; and why from all Waters of this Claſs we obtain a *Neutral* Salt of the ſame kind.†

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† In Pyrmontanis, in librâ unâ Salis medii grana vii ad x continentur; in Egranis & Salterenſibus grana plura; in Sualbecenſibus & Spadanis, pauciora.—*Heiſter de Aquar. Medicatarum naturâ et uſu.*

HOFFMAN, ſpeaking of this Salt, obſerves, '† That it cannot be diſcover'd, 'by the addition of any particular Sub'ſtances to the Water, but readily by 'exhaling it to a dryneſs:'—For which, if the above ſuppoſition is admitted, we can be at no loſs to account.

THE laſt thing to be explained, is the remarkable heat with which theſe Waters are endued; and here, if I have recourſe to the antient Opinion, that Fire is an Element ſui generis, and that it makes a part in the compoſition of all Bodies whatever; I ſhall not be unſupported by many great Names among the Moderns, ſuch as *Homberg*, *Lemery*, *Graveſande*, and *Boerhaave*. It may alſo be added, that the late

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‡ Quod reagentium ope difficulter admodum, vel plane non erui & detegi poſſit, ſed ſola Liquoris *exhalatione* & *reſiccatione* ſeſe conſpiciendum præbeat.—*Hoffman de Elementis Aquarum Mineralium, &c. Sect.* 50.

difdiſcoveries in Electricity tend very much to confirm and eſtabliſh this Doctrine. I chooſe therefore to aſcribe that great degree of Heat which is found in the Bath Waters to Elementary Fire, as to its moſt probable Cauſe. *This*, if it exiſts in any Bodies at all, does ſo moſt eminently in Iron and Brimſtone. It ſhould ſeem then, that theſe Waters, by waſhing off, ſeparating, and taking up, in their paſſage thro' the Earth, the Particles of theſe Minerals, ſet at liberty this impriſoned *Element*, which thereupon communicates its Warmth and Activity to the Fluid.

I KNOW not, whether I have given the Reader all the Satisfaction he expected in the peruſal of the foregoing Sheets. This I am ſure of, that the Experiments were carefully made, and the Succeſs of them is faithfully related. The great Mr. *Boyle* obſerves, that ' To diſcover the Nature of Mineral

‘ Waters, is a far more difficult taſk than ‘ thoſe who have not tried would imagine.’ The difficulties I met with in the preceding Analyſis, have thoroughly convinced me of the Juſtneſs of this Obſervation. But in proportion as the Attempt is arduous, the Candour and Indulgence of the Public may be hoped for. To them therefore it is ſubmitted, with that unprejudiced Temper of Mind which ought to be inſeparable from every Enquirer after Truth : And if any Gentleman who may make theſe Experiments after me, or may fall upon others more deciſive, ſhould diſcover any Errors in this little Tract, its Author will thank him for the Information.

*FINIS.*

Fig: 1

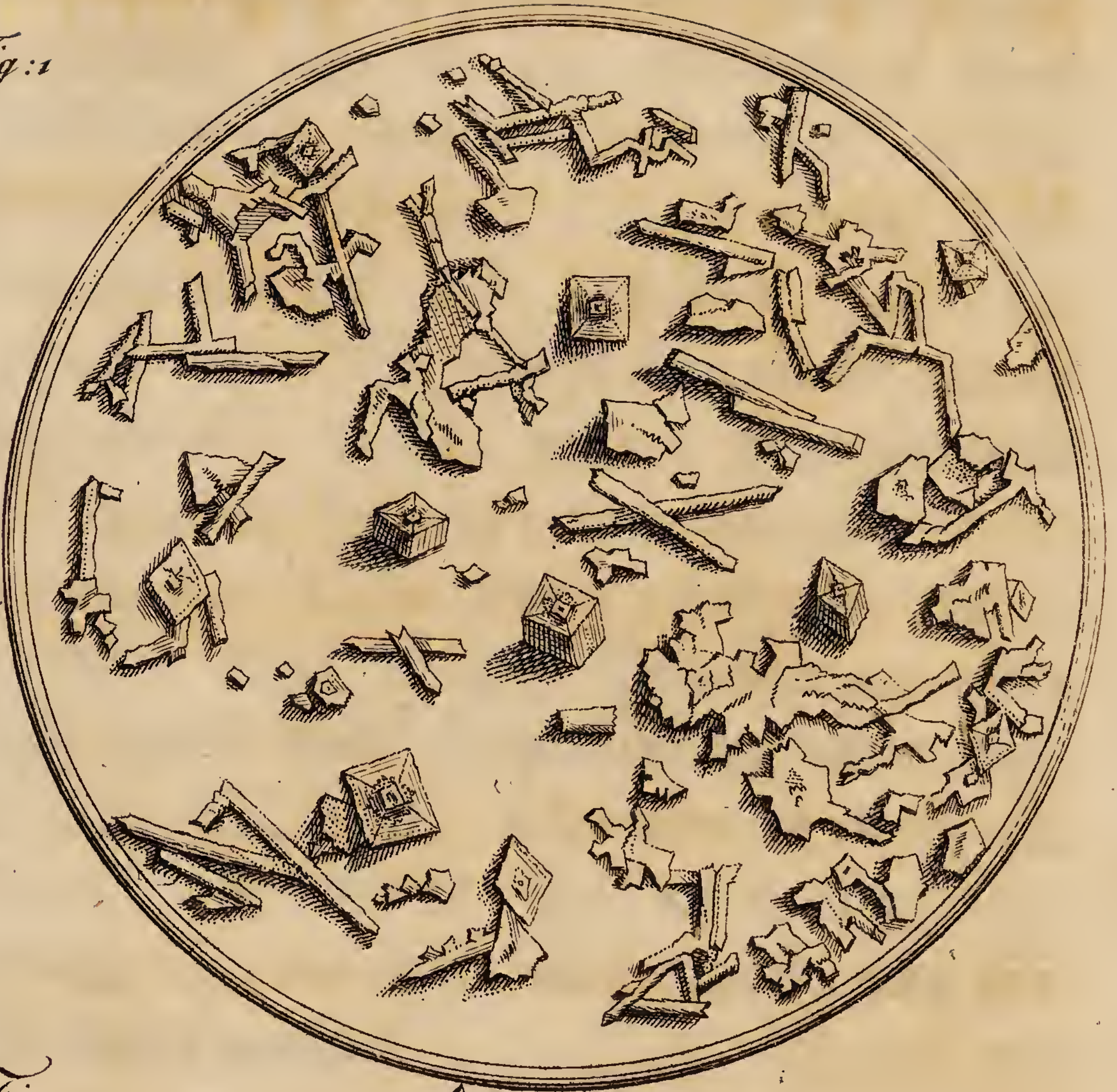

Fig: 2

# AN EXPLANATION OF THE *Copper-Plate.*

### FIG. I.

*Shews the Salts of the Bath Water, as they cryſtaliz'd at the bottom of a Glaſs Pan.*

*The* Squares *are Marine Salt.*

*The* long Cryſtals *are Calcarious Nitre.*

*The* irregular Figures *are made up of both, and are occaſion'd by theſe Salts ſhooting too near together, and thence preventing each other's Cryſtals from forming in their own, determinate Shape.*

FIG.

### FIG. 2.

*Exhibits a Cryſtal of the Calcarious Nitre drawn from the Microſcope; with ſeveral portions of Marine Salt adhering to it.*

### *E R R A T A.*

Page 4, Note 2, read *Synopſis.*—Page 5, Note, read *Gaudet.*—Page 9, Line 2, read *Eſſays.*—Page 49, Line 9, read *Priſmatic.*

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